APPENDIX B

INTERIM REPORT ON TASK 2: ENERGY BASELINE EVALUATION AND CHP AND ECONOMIC AND ENGINEERING OPTIONS

PACIFIC MISSILE RANGE FACILITY
COMBINED HEAT AND POWER FEASIBILITY STUDY

INTERIM REPORT ON TASK 2
Energy Baseline Evaluation and
CHP Economic and Engineering Options

Prepared For:

County of Kauai
Office of Economic Development
Kauai, Hawaii

Prepared By:

SCS Energy
Long Beach, California

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PACIFIC MISSILE RANGE FACILITY
COMBINED HEAT AND POWER FEASIBILITY STUDY

INTERIM REPORT ON TASK 2

TABLE OF CONTENTS

PACIFIC MISSILE RANGE FACILITY
COMBINED HEAT AND POWER FEASIBILITY STUDY

INTERIM REPORT ON TASK 2

TABLE OF CONTENTS (continued...)

Section **Page**

Tables and Figures

Appendices

SECTION 1

INTRODUCTION

The County of Kauai Office of Economic Development engaged SCS Energy (SCS) to conduct a combined heat and power (CHP) feasibility study for the Pacific Missile Range Facility (PMRF). Task 2 of the work plan for this study calls for:

- Evaluation of all existing PMRF energy data, electric load profiles, and thermal load profiles for the purpose of establishing a facility baseline;
- Development of an inventory of major equipment;
- Identification of plans for equipment replacement, and site modifications and expansions;
- Development of economic and engineering options for a CHP project, including consideration of: replacement of the existing PMRF power plant with a new CHP plant; retrofitting the existing PMRF power plant; constructing a backup CHP plant; or other options determined by SCS to be viable;
- Identification of interconnection equipment/standards of the Kauai Island Utility Cooperative (KIUC);
- Identification of air emissions and air emissions standards that would govern modifications to the existing PMRF power plant or a new power plant; and
- Submittal of a Task 2 report.

SECTION 2

ENERGY BASELINE EVALUATION

Electric Power Distribution System

The Pacific Missile Range Facility (PMRF) provided SCS with single line diagrams and with utilities composite maps. The utilities composite maps show the physical locations of the main on-site electric power distribution lines, and the location of the larger transformers. The diagrams and drawings are not reproduced herein because of their size. The most relevant information shown on the diagrams and drawings is summarized below.

PMRF interconnects with Kauai Island Utility Cooperative (KIUC) at five locations. The power distribution systems at PMRF behind these connections to KIUC are not interconnected between each other within PMRF. The four larger interconnection points are as follows:

- The first interconnection is at the extreme southern end of PMRF, and is immediately adjacent to the Kekaha Landfill. The interconnection at this point is known to PMRF as "Kokole Point." The connection to KIUC is at 12.47 kV. The main distribution line within PMRF parallels Kokole Point Road, and continues through at 12.47 kV to the last significant point of use on this interconnection. At several locations, power is transformed down to 480 V, 240 V or 120 V. PMRF has two emergency generators on this circuit;
- The second interconnection point to KIUC by PMRF, moving northward, is known to PMRF as "Navy Housing." The connection at this point is at 12.47 kV. The main transmission line within PMRF is at 12.47 kV and it parallels Tartar Drive. The power is then transformed down to 480 V and lower voltages at various locations;
- The third interconnection point, moving northward, is known to PMRF as "PMRF Main Base." The interconnection to KIUC is at 12.47 kV. The distribution line into PMRF parallels Imiloa Road. At various locations, the voltage is transformed down to 4,160 V, 480 V and lower. The existing PMRF power plant is tied into this electrical distribution system. The power plant is located at the southern end of the electrical distribution system. The power plant generates power at 4,160 V. The power is stepped up to 12.47 kV at the power plant. The northern end of this distribution system provides electrical service to the main hangar; and
- The northern most point of connection to KIUC is at what PMRF calls the "North Gate." KIUC service is provided at 12.47 kV.

The shortest distance between the 12.47 kV line at the Kokole Point power distribution system and the power distribution system at Navy Housing is about 2,000 feet. An interconnection between these two power distribution systems could be accomplished through construction of an interconnecting transmission line paralleling Nohili Road. One of the points of interconnection to KIUC would need to be eliminated. In addition to the usual physical obstacles to be overcome in making such an interconnection, there are some ownership issues that will need to be addressed. Not all of the high voltage distribution line segments within PMRF are owned by PMRF, as some of the lines within PMRF are actually owned by KIUC.

The shortest distance between the 12.47 kV line at the northern end of the Navy Housing power distribution system and the southern end of the PMRF Main Base power distribution system is 10,000 feet. An interconnection between these two power distribution systems could be accomplished through the construction of an interconnecting transmission line paralleling Nohili Road. PMRF advises that it is likely that the transmission line would need to be installed underground, due to its proximity to the runway.

The northern end of the PMRF Main Base distribution system could be interconnected to the southern end of the North Gate distribution system through the installation of about 900 feet of 12.47 kV transmission line in an open field. Again, issues of PMRF and KIUC line ownership may cause administrative issues in addition to physical issues.

Electric Power Purchases

PMRF told SCS that only three of the points of interconnection with KIUC drew significant quantities of electric power -- PMRF Main Base; Navy Housing; and Kokole Point. PMRF provided SCS with copies of the KIUC electric bills for these three points of interconnection for September 2003 through April 2006.

SCS analyzed these bills and developed Table Nos. 2-1, 2-2 and 2-3. Table No. 2-1 summarizes key data for the PMRF Main Base point of service:

- The metered peak power demand (i.e., the highest running 15-minute average) is about 1,400 kW, and does not vary greatly by season;
- The average demand (total monthly kWh divided by total hours in a month) is about 700 kW to 800 kW;
- Power consumption is about 500,000 kWh to 600,000 kWh per month. In 2004 and 2005, total annual power consumption was 6,502,000 kWh and 6,493,200 kWh, respectively; and
- Electric power cost has ranged from a low of $0.22/kWh in 2003 to a high of $0.31/kWh in 2006.

Table No. 2-2 summarizes key data for the Navy Housing point of service:

- The metered peak power demand is about 700 kW, and does not vary greatly by season;
- The average demand is about 300 kW to 400 kW;
- Power consumption is about 250,000 kWh to 300,000 kWh per month. In 2004 and 2005, total annual power consumption was 2,985,600 kWh and 3,328,200 kWh, respectively;
- Electric power cost has ranged from a low of $0.21/kWh in 2003 to a high of $0.31/kWh in 2006.

Table No. 2-3 summarizes key data for the Kokole Point point of service:

- The metered peak power demand is about 95 kW, and does not vary greatly by season;
- The average demand is about 50 kW to 60 kW;
- Power consumption is about 35,000 kWh to 40,000 kWh per month. In 2004 and 2005, total annual power consumption was 441,032 kWh and 467,360 kWh, respectively;
- Electric power cost has ranged from a low of $0.22/kWh in 2003 to a high of $0.32/kWh in 2006.

Table No. 2-4 combines data from Table Nos. 2-1, 2-2 and 2-3 to provide the aggregated power consumption and cost for all three points of service.

On-Site Power Generation

Equipment Description

PMRF is currently operating an on-site power plant. The power plant employs six reciprocating engines. The engines designated Engine Nos. 1, 2 and 3 are Caterpillar Model 3412. The engines designated Engine Nos. 7 and 8 are Caterpillar Model 3508.

Engine Nos. 1, 2 and 3 have individual nameplate capacities of 300 kW. The engines were installed circa 1986-1987. Engine Nos. 7 and 8 have individual nameplate capacities of 600 kW. The engines were installed circa 1998-1999. The total installed capacity at the power plant is 2,100 kW.

All five engines generate power at 4,160 kV. The power is aggregated, is stepped up to 12.47 kV, and is delivered into the PMRF Main Base power distribution system. All five engines are fired on No. 2 fuel oil.

The generators on Engine Nos. 1, 2 and 3 are protected by Basler protective relays for over current and for ground fault over current. Brown Boveri protective relays provide protection for reverse power, differential power and regular sequence over current. Engine Nos. 7 and 8 are each equipped with a Beckwith M-3420, which performs all of the required protective functions.

The tie point to the PMRF distribution grid, which is essentially the tie to KIUC, is equipped with General Electric (GE) protective relays for over current, directional over current, and over current ground. These GE relays provide protection to PMRF's distribution grid, as contrasted to the previously described relays which individually protect the generators. The PMRF power plant has the ability to operate in parallel with or in isolation from KIUC.

Diesel Fuel Consumption

Table No. 2-5 tabulates monthly diesel oil consumption at the PMRF power plant for Federal Fiscal Years 2004 through 2006. The power plant uses about 10,000 gallons of diesel oil per month. Table No. 2-5 also tabulates the cost of the diesel oil. Diesel oil is stored in three underground 10,000-gallon tanks.

Power Generation

PMRF told SCS that the power plant operates Monday through Friday from 7:30 a.m. to 3:30 p.m. The power plant does not operate on federal holidays.

During SCS's site visit on January 10, 2006, SCS observed Engine Nos. 3, 7 and 8 to be operating at 160 kW, 210 kW and 210 kW, respectively. During SCS's site visit on August 3, 2006, SCS observed Engine Nos. 3, 7 and 8 to be operating at 160 kW, 260 kW and 260 kW, respectively.

PMRF provided SCS with a tabulation of total kWh produced (monthly basis) for Fiscal Years 2004 through 2006. Power production data is not available on an hourly or daily basis. SCS combined the power production data with diesel oil consumption and cost data to prepare Table Nos. 2-6, 2-7 and 2-8 to calculate:

- Average kWh produced per operating day;
- Power production cost, based on diesel fuel cost alone; and
- Engine heat rate (Btu of fuel consumed per kWh of electricity).

The average kWh produced per day is in general agreement with PMRF's statement that the engines run eight hours per day, and with SCS's observation that the power plant was producing 580 kW and 680 kW during SCS's site visits.

The cost of electric power production has increased from $0.11/kWh to $0.22/kWh, as a consequence of rising oil prices.

The heat rate of the engines averaged 11,125 Btu/kWh during the period covered by the tables. A heat rate of 11,125 Btu/kWh is equivalent to an efficiency of about 30.7 percent.

Thermal Energy Consumption

PMRF does not have a central plant for the production of steam, hot water or chilled water. PMRF does not have thermal energy plants that serve clusters of buildings. Virtually every building has its own hot water generation facilities, if a building requires hot water, or has its own stand-alone air conditioning system. PMRF spans a distance of over five miles from the Kokole Point to the North Hangar. As a consequence, the thermal loads are generally not close together. Most of the buildings are relatively small in size, and do not generate appreciable thermal loads.

Diagrams have been provided in Appendix A which show the physical locations of the buildings identified below.

Hot Water

PMRF has no use for steam. Consequently, there are no boilers at PMRF.

Hot water use at PMRF is limited to residential, restroom and cleanup purposes. There is no process demand for hot water. Hot water demands are small, and are widely distributed. Hot water is produced by domestic or small commercial hot water heaters. The hot water heaters use electricity, solar energy, and occasionally propane.

PMRF was able to identify only one significant concentrated hot water demand. It is centered at a hot water generator in Building 1262. The hot water generator serves the galley in Building 1262 and the Visitor Quarters in Building 1261.

The hot water generator has the following characteristics.

Manufacturer	Teledyne Laars
Input	400,000 Btu/hr
Output	324,000 Btu/hr
Hot Water Storage Tank Water Temperature	140° F
Hot Water Pumps	Two at ¾ hp
Propane Storage Tank	500 gallons

The above information was taken off of the nameplates on the equipment during a field inspection.

The propane at this location is used for cooking and for hot water heating. Records are not available for actual propane use at this location.

The galley is located about 10,000 feet from the existing PMRF power plant. It is not feasible to supply hot water to this location from the location of the existing PMRF power plant.

Chilled Water

Air conditioning is provided at PMRF for the purposes of personnel comfort and for equipment protection. The air conditioning is supplied through a wide range of equipment:

- Window-mounted units;
- Units with a condenser located outside a building with circulation of an organic coolant to indoor wall-mounted units;
- Units which duct cold air into the buildings; and
- Units which produce cold water (chillers), with the chilled water distributed through the buildings.

The buildings which are served by chillers offer the only reasonable opportunities for use of thermal energy generated by power production. The buildings served by chillers generally have the highest air conditioning loads, and chilled water can be produced from steam or hot water, using absorption chiller technology.

PMRF identified four buildings served by chillers -- Building 105, Building 130, Building 300 and Building 384. Technical information on the chillers was obtained, during a field inspection, from the nameplates on the equipment at these four buildings, and at four other buildings -- Building 1261, Building 1262, Building 1264, and Building 105ROCS.

The air conditioning equipment at Building 1261, Building 1262 and Building 1264, while not chillers, was inspected. Building 1262 is the galley, and Buildings 1261 and 1264 are located close to Building 1262. It was felt that a "thermal load cluster" might be established around Building 1262. It might be possible to satisfy such a thermal load cluster through waste heat from a "micro" power plant located at Building 1262. A fourth building, Building 105ROCS, was also inspected because it abuts Building 105, and it may present an opportunity to coordinate air conditioning loads with Building 105.

The following paragraphs summarize the information collected on the air conditioning systems at the eight buildings.

Building 105 is also known as the Range Operations Center. It is served by two air-cooled chillers, which are located adjacent to each other. Building 105 appears to have the largest

cooling demand at PMRF. Building 105 is located only about 500 feet away from the existing PMRF power plant. The chillers are identical in characteristics and differ only in their serial number.

Type	Carrier
Model	30GOS-060-C610
Serial Nos.	1697F67756/1697F67775
Two Compressors	46.8 RLA and 65.4 RLA
Voltage	480 V

Carrier technical information indicates that each chiller has a maximum power draw of 70 kW and will produce 60 tons of cooling. At the time of the visit, cold water was being delivered at 49° F and warm water was returned at 61.5° F.

Building 105ROCS is immediately adjacent to Building 105. Building 105ROCS is served by an air-cooled condenser-type unit. The nameplate information on this unit is as follows:

Type	McQuay
Model	ACD115A27BH
Serial No.	TO3B2234
Compressor	29 amp minimum/35 amp maximum
Voltage	480 V
Condenser Fans	Eight at 1 ½ horsepower

It was not possible to contact the manufacturer for additional information. SCS estimates that the capacity of the unit is 115 tons. During the site visit, the unit appeared to be operating at 50 percent load.

Building 105ROCS was also being served by a temporary air-cooled chiller. The following nameplate information was collected:

Type	Carrier
Model	30RAN030DS-615PP
Serial No.	0306905088
Compressor	Two at 23.8 RLA
Voltage	480 V

Carrier technical information indicates that the capacity of this unit is 27 tons, and has a maximum power draw of 32 kW.

Building 130 is a radar building and the principal air conditioning requirement at this building is equipment cooling. Building 130 is only 100 feet away from the existing PMRF power plant.

The following nameplate information was obtained off of Building 130's air-cooled chiller:

Type	Technical Systems/RAE Corporation
Model	30A0LD20
Serial No.	1-96 F35801
Compressor	Minimum circuit capacity = 100 amps
Voltage	480 V

RAE technical information indicates that the capacity of this unit is 18 tons, with a maximum power draw of 20 kW.

Total installed cooling capacity for the above three buildings, which are all located within 500 feet of the existing PMRF power plant, is 280 tons.

Building 300 is a fire station and control tower. It is located about 2,700 feet north of the existing PMRF power plant. Its distance from the power plant makes its inclusion in a CHP project unlikely. Nameplate information on this unit is as follows:

Type	Carrier Aquasnap
Model	30RAN025 511 KV
Serial No.	1105403752
Compressors	Two at 40.8 RLA
Voltage	480 V

Carrier technical information indicates that the capacity of this air-cooled chiller is 24 tons, and it has a maximum power draw of 30 kW.

Building 384 is an aircraft hangar. It is located about 3,700 feet north of the existing PMRF power plant. Its distance from the power plant makes it unlikely that it could be included within a CHP project. Nameplate information on the chiller is as follows:

Type	Dunham-Bush
Model	AC60A
Serial No.	81069201A88B
Compressors	Two at 48.6 RLA
Voltage	480 V

During SCS's site visit, the cold water temperature was observed to be 54° F and the warm water being returned was 73° F. Dunham-Bush technical information indicates that the capacity of this air-cooled chiller is 60 tons.

Building 1262 is served by a relatively new air conditioning unit. Its nameplate information is as follows:

Type	Lennox L Series
Model	C8290
Serial No.	5605H 00801
Evaporator	5 hp
Fans	Four at 1/3 hp
Exhaust Fans	Two at 1/3 hp

Lennox technical information indicates that the capacity of this unit is 7 tons, with a maximum power draw of 10 kW.

Building 1261, about 200 feet east of Building 1262, is equipped with a direct expansion cooling unit. Nameplate information is as follows:

Type	McQuay Schneider
Model	LSL 117DH
Serial No.	WA00487-04
Fan Motors	Three at 1 hp
Compressor	25 hp

SCS could find no technical information on this unit, but estimates the capacity to be about 18 tons with a power requirement of about 20 kW.

Building 1264 is a recreation center. It is about 350 feet northeast of Building 1262. It employs a direct expansion cooling unit with the following nameplate information:

Type	Carrier
Model	Weathermaster
Serial No.	38AA-024-FSHA
Compressors	Two at 39.3 RLA

Carrier technical information indicates that the capacity of this unit is 24 tons, with a maximum power draw of 28 kW.

Building No. 1260 has an air-cooled condensing unit with a capacity of 12 tons. Nameplate information is as follows:

Type	McQuay
Model	AC2016AC12-ER11
Serial No.	STNU050900180
Fan Motors	One at 2 hp
Compressors	Two

The total installed cooling capacity, serving the above four buildings, which form a cooling cluster around and including Building 1262, is about 60 tons. Inclusion of these buildings in a "micro" CHP project located at Building 1262 would require that the equipment inside these buildings be retrofitted for chilled water.

Planned Facilities

PMRF indicated that there are no plans for new buildings at the base, no plans for modifying the existing PMRF power plant, and no plans for major upgrades to cooling facilities.

TABLE NO. 2-1
ELECTRIC POWER PURCHASES FROM KIUC
FROM SEPTEMBER 2003 TO APRIL 2006
PMRF MAIN BASE POINT OF SERVICE

Date		Days	Demand (kW)	kWh	Calculated	Monthly Bill	Calculated
Beginning	End				Average kW	($)	$/kWh
9/17/2003	10/17/2003	30	1350	552600	768	$120,624.43	$0.22
10/17/2003	11/14/2003	28	1350	529800	788	$114,075.96	$0.22
11/14/2003	12/12/2003	28	1296	468000	696	$103,024.99	$0.22
12/12/2003	1/14/2004	33	1230	552600	698	$119,647.47	$0.22
1/14/2004	2/13/2004	30	1284	494400	687	$111,132.98	$0.22
2/13/2004	3/15/2004	31	1230	503400	677	$113,616.40	$0.23
3/15/2004	4/14/2004	30	1248	499200	693	$114,978.27	$0.23
4/14/2004	5/14/2004	30	1356	520200	723	$127,740.50	$0.25
5/14/2004	6/10/2004	27	1386	518400	800	$135,897.13	$0.26
6/10/2004	7/12/2004	32	1386	563400	734	$147,395.76	$0.26
7/12/2004	8/12/2004	31	1428	606600	815	$151,420.84	$0.25
8/12/2004	9/13/2004	32	1410	646800	842	$162,891.12	$0.25
9/13/2004	10/13/2004	30	1446	592800	823	$154,136.35	$0.26
10/13/2004	11/12/2004	30	1392	534600	743	$146,036.66	$0.27
11/12/2004	12/10/2004	28	1308	505200	752	$143,095.31	$0.28
12/10/2004	1/12/2005	33	1230	567000	716	$150,061.31	$0.26
1/12/2005	2/14/2005	33	1272	552000	697	$140,108.80	$0.25
2/14/2005	3/17/2005	31	1236	489000	657	$129,233.07	$0.26
3/17/2005	4/18/2005	32	1290	546600	712	$152,980.95	$0.28
4/18/2005	5/16/2005	28	1290	498000	741	$147,986.05	$0.30
5/16/2005	6/17/2005	32	1386	610800	795	$177,506.61	$0.29
6/17/2005	7/18/2005	31	1350	600000	806	$170,337.42	$0.28
7/18/2005	8/15/2005	28	1392	498000	741	$146,052.25	$0.29
8/15/2005	9/12/2005	31	1350	600000	806	$170,337.42	$0.28
9/12/2005	10/11/2005	29	1416	558600	803	$177,145.14	$0.32
10/11/2005	11/10/2005	30	1374	525600	730	$174,319.70	$0.33
11/10/2005	12/9/2005	29	1242	471600	678	$106,114.35	$0.23
12/9/2005	1/11/2006	33	1194	543000	686	$161,665.83	$0.30
1/11/2006	2/10/2006	30	1218	483000	671	$141,409.84	$0.29
2/10/2006	3/13/2006	31	1092	441600	594	$132,043.23	$0.30
3/13/2006	4/13/2006	31	1128	466800	627	$142,128.10	$0.30
4/13/2006	5/15/2006	32	1182	507000	660	$158,933.92	$0.31

TABLE NO. 2-2
ELECTRIC POWER PURCHASES FROM KIUC
FROM SEPTEMBER 2003 TO APRIL 2006
NAVY HOUSING POINT OF SERVICE

Date		Days	Demand (kW)	kWh	Calculated	Monthly Bill	Calculated
Beginning	End				Average kW	($)	$/kWh
9/17/2003	10/17/2003	30	648	282000	392	$59,823.01	$0.21
10/17/2003	11/14/2003	28	630	245400	365	$52,198.95	$0.21
11/14/2003	12/12/2003	28	564	228600	340	$48,767.18	$0.21
12/12/2003	1/14/2004	33	552	258000	326	$54,775.89	$0.21
1/14/2004	2/13/2004	30	606	247200	343	$54,373.16	$0.22
2/13/2004	3/15/2004	31	570	248400	334	$54,543.51	$0.22
3/15/2004	4/14/2004	30	570	117600	163	$56,164.48	$0.48
4/14/2004	5/14/2004	30	576	253200	352	$59,967.99	$0.24
5/14/2004	6/10/2004	27	612	242400	374	$62,029.91	$0.26
6/10/2004	7/12/2004	32	600	285000	371	$71,409.33	$0.25
7/12/2004	8/12/2004	31	678	295800	398	$72,336.44	$0.24
8/12/2004	9/13/2004	32	672	306600	399	$76,311.09	$0.25
9/13/2004	10/13/2004	30	648	274800	382	$70,141.50	$0.26
10/13/2004	11/12/2004	30	612	256200	356	$68,148.63	$0.27
11/12/2004	12/10/2004	28	594	216600	322	$61,044.34	$0.28
12/10/2004	1/12/2005	33	546	241800	305	$63,866.64	$0.26
1/12/2005	2/14/2005	33	582	263400	333	$65,860.32	$0.25
2/14/2005	3/17/2005	31	546	246600	331	$63,146.76	$0.26
3/17/2005	4/18/2005	32	600	276600	360	$75,633.42	$0.27
4/18/2005	5/16/2005	28	672	255600	380	$75,512.68	$0.30
5/16/2005	6/17/2005	32	726	319200	416	$91,957.14	$0.29
6/17/2005	7/18/2005	31	750	318000	427	$90,144.03	$0.28
7/18/2005	8/15/2005	28	696	283800	422	$81,079.54	$0.29
8/15/2005	9/12/2005	28	726	292200	435	$86,731.84	$0.30
9/12/2005	10/11/2005	29	726	289200	416	$90,741.50	$0.31
10/11/2005	11/10/2005	30	660	277200	385	$90,249.42	$0.33
11/10/2005	12/9/2005	29	690	248400	357	$56,787.53	$0.23
12/9/2005	1/11/2006	33	690	258000	326	$77,961.21	$0.30
1/11/2006	2/10/2006	30	636	236400	328	$69,396.44	$0.29
2/10/2006	3/13/2006	31	588	243600	327	$71,925.27	$0.30
3/13/2006	4/13/2006	31	588	252600	340	$75,813.82	$0.30
4/13/2006	5/15/2006	32	630	270000	352	$83,960.09	$0.31

TABLE NO. 2-3
ELECTRIC POWER PURCHASES FROM KIUC
FROM SEPTEMBER 2003 TO APRIL 2006
KOKOLE POINT POINT OF SERVICE

Date		Days	Demand (kW)	kWh	Calculated Average kW	Monthly Bill ($)	Calculated $/kWh
Beginning	End						
9/17/2003	10/17/2003	30	94.8	42480	59	$9,238.12	$0.22
10/17/2003	11/14/2003	28	94.8	34560	51	$7,718.29	$0.22
11/14/2003	12/12/2003	28	82.8	35520	53	$7,785.00	$0.22
12/12/2003	1/14/2004	33	82.8	34800	44	$7,847.03	$0.23
1/14/2004	2/13/2004	30	82.8	34320	48	$7,819.30	$0.23
2/15/2004	3/16/2004	30	75.6	7952	11	$2,831.86	$0.36
3/16/2004	4/15/2004	30	82.8	38160	53	$8,867.58	$0.23
4/15/2004	5/14/2004	29	82.8	39000	56	$9,409.36	$0.24
5/14/2004	6/10/2004	27	91.2	34560	53	$9,182.35	$0.27
6/10/2004	7/12/2004	32	82.8	42840	56	$10,867.04	$0.25
7/12/2004	8/12/2004	31	94.8	46680	63	$11,447.76	$0.25
8/12/2004	9/13/2004	32	88.8	48840	64	$12,064.24	$0.25
9/13/2004	10/13/2004	30	93.6	40920	57	$10,670.11	$0.26
10/13/2004	11/12/2004	30	97.2	37920	53	$10,458.40	$0.28
11/12/2004	12/10/2004	28	78	34080	51	$9,662.03	$0.28
12/10/2004	1/12/2005	33	78	35760	45	$9,674.04	$0.27
1/12/2005	2/14/2005	33	78	39000	49	$9,869.36	$0.25
2/14/2005	3/17/2005	31	74.4	36840	50	$9,571.53	$0.26
3/17/2005	4/18/2005	32	76.8	40320	53	$11,092.83	$0.28
4/18/2005	5/16/2005	28	84	34320	51	$10,322.25	$0.30
5/16/2005	6/17/2005	32	84	42240	55	$12,212.19	$0.29
6/17/2005	7/18/2005	31	84	41520	56	$11,775.92	$0.28
7/18/2005	8/15/2005	28	94.8	41280	61	$11,970.93	$0.29
8/15/2005	9/12/2005	28	94.8	39960	59	$12,090.05	$0.30
9/12/2005	10/11/2005	29	87.6	39360	57	$12,448.62	$0.32
10/11/2005	11/10/2005	30	86.4	39840	55	$13,086.13	$0.33
11/10/2005	12/9/2005	29	81.6	35760	51	$8,269.85	$0.23
12/9/2005	1/11/2006	33	81.6	34920	44	$10,676.48	$0.31
1/11/2006	2/10/2006	30	81.6	32040	45	$9,634.17	$0.30
2/10/2006	3/13/2006	31	75.6	33840	45	$10,164.79	$0.30
3/13/2006	4/13/2006	31	86.4	33240	45	$10,396.75	$0.31
4/13/2006	5/15/2006	32	86.4	37200	48	$11,847.95	$0.32

TABLE NO. 2-4
ELECTRIC POWER PURCHASES FROM KIUC
TOTAL FROM THREE POINTS OF SERVICE

Time Scale			Bonham Air Field, Navy Housing and Scatter Station Summation				
Date		Days	Demand (kW)	kWh	Calculated Average kW	Monthly Bill ($)	Calculated $/kWh
Beginning	End						
9/17/2003	10/17/2003	30	2093	877080	1218	$189,685.56	$0.22
10/17/2003	11/14/2003	28	2075	809760	1205	$173,993.20	$0.21
11/14/2003	12/12/2003	28	1943	732120	1089	$159,577.17	$0.22
12/12/2003	1/14/2004	33	1865	845400	1067	$182,270.39	$0.22
1/14/2004	2/13/2004	30	1973	775920	1078	$173,325.44	$0.22
2/15/2004	3/16/2004	30	1876	759752	1055	$170,991.77	$0.23
3/16/2004	4/15/2004	30	1901	654960	910	$180,010.33	$0.27
4/15/2004	5/14/2004	29	2015	812400	1167	$197,117.85	$0.24
5/14/2004	6/10/2004	27	2089	795360	1227	$207,109.39	$0.26
6/10/2004	7/12/2004	32	2069	891240	1160	$229,672.13	$0.26
7/12/2004	8/12/2004	31	2201	949080	1276	$235,205.04	$0.25
8/12/2004	9/13/2004	32	2171	1002240	1305	$251,266.45	$0.25
9/13/2004	10/13/2004	30	2188	908520	1262	$234,947.96	$0.26
10/13/2004	11/12/2004	30	2101	828720	1151	$224,643.69	$0.27
11/12/2004	12/10/2004	28	1980	755880	1125	$213,801.68	$0.28
12/10/2004	1/12/2005	33	1854	844560	1066	$223,601.99	$0.26
1/12/2005	2/14/2005	33	1932	854400	1079	$215,838.48	$0.25
2/14/2005	3/17/2005	31	1856	772440	1038	$201,951.36	$0.26
3/17/2005	4/18/2005	32	1967	863520	1124	$239,707.20	$0.28
4/18/2005	5/16/2005	28	2046	787920	1173	$233,820.98	$0.30
5/16/2005	6/17/2005	32	2196	972240	1266	$281,675.94	$0.29
6/17/2005	7/18/2005	31	2184	959520	1290	$272,257.37	$0.28
7/18/2005	8/15/2005	28	2183	823080	1225	$239,102.72	$0.29
8/15/2005	9/12/2005	28	2171	932160	1387	$269,159.31	$0.29
9/12/2005	10/11/2005	29	2230	887160	1275	$280,335.26	$0.32
10/11/2005	11/10/2005	30	2120	842640	1170	$277,655.25	$0.33
11/10/2005	12/9/2005	29	2014	755760	1086	$171,171.73	$0.23
12/9/2005	1/11/2006	33	1966	835920	1055	$250,303.52	$0.30
1/11/2006	2/10/2006	30	1936	751440	1044	$220,440.45	$0.29
2/10/2006	3/13/2006	31	1756	719040	966	$214,133.29	$0.30
3/13/2006	4/13/2006	31	1802	752640	1012	$228,338.67	$0.30
4/13/2006	5/15/2006	32	1898	814200	1060	$254,741.96	$0.31

TABLE NO. 2-5
DIESEL OIL CONSUMPTION AND COSTS
PMRF POWER PLANT

Month/Year	Fuel Gallons	Fuel Total Cost	Cost Per Gallon
Oct-03	11,251	$16,651.48	$1.48
Nov-03	7,786	$11,523.28	$1.48
Dec-03	8,956	$13,254.88	$1.48
Jan-04	9,042	$11,573.76	$1.28
Feb-04	9,873	$14,612.63	$1.48
Mar-04	11,341	$16,784.68	$1.48
Apr-04	10,547	$15,610.45	$1.48
May-04	9,679	$14,325.22	$1.48
Jun-04	12,950	$21,109.97	$1.63
Jul-04	16,651	$28,473.21	$1.71
Aug-04	10,335	$17,983.59	$1.74
Sep-04	10,051	$18,294.46	$1.82
Oct-04	12,102	$23,842.71	$1.97
Nov-04	10,757	$21,729.34	$2.02
Dec-04	7,662	$15,477.24	$2.02
Jan-05	8,123	$16,164.77	$1.99
Feb-05	13,877	$26,921.57	$1.94
Mar-05	11,660	$23,204.39	$1.99
Apr-05	12,504	$25,508.16	$2.04
May-05	9,348	$19,537.53	$2.09
Jun-05	10,075	$21,057.80	$2.09
Jul-05	11,631	$24,657.72	$2.12
Aug-05	17,617	$41,049.47	$2.33
Sep-05	10,227	$26,387.72	$2.58
Oct-05	10,219	$27,388.79	$2.68
Nov-05	12,327	$31,805.72	$2.58
Dec-05	5,904	$15,234.38	$2.58

TABLE NO. 2-5 (continued...)
DIESEL OIL CONSUMPTION AND COSTS
PMRF POWER PLANT

Month/Year	Fuel Gallons	Fuel Total Cost	Cost Per Gallon
Jan-06	7,529	$17,168.17	$2.28
Feb-06	10,060	$22,937.71	$2.28
Mar-06	9,733	$22,677.89	$2.33
Apr-06	14,415	$33,587.64	$2.33
May-06	10,733	$27,155.24	$2.53
Jun-06	14,177	$36,860.20	$2.60

TABLE NO. 2-6
2004 POWER PRODUCTION, PLANT EFFICIENCY AND POWER PRODUCTION COSTS

Month	Total kWh	Days in Month	Average kWh Per Day	Average kW	Fuel Gallons	Fuel Total Cost	$/kWh	Btu/kWh
Oct-03	147,210	31	4,749	198	11,251	$16,651.48	$0.11	10,770
Nov-03	102,900	30	3,430	143	7,786	$11,523.28	$0.11	10,662
Dec-03	116,165	31	3,747	156	8,956	$13,254.88	$0.11	10,864
Jan-04	114,975	31	3,709	155	9,042	$11,573.76	$0.10	11,082
Feb-04	126,700	28	4,525	189	9,873	$14,612.63	$0.12	10,980
Mar-04	150,395	31	4,851	202	11,341	$16,784.68	$0.11	10,626
Apr-04	136,710	30	4,557	190	10,547	$15,610.45	$0.11	10,871
May-04	126,000	30	4,200	175	9,679	$14,325.22	$0.11	10,824
Jun-04	161,210	30	5,374	224	12,950	$21,109.97	$0.13	11,319
Jul-04	220,150	31	7,102	296	16,651	$28,473.21	$0.13	10,658
Aug-04	136,605	31	4,407	184	10,335	$17,983.59	$0.13	10,661
Sep-04	131,670	30	4,389	183	10,051	$18,294.46	$0.14	10,756

TABLE NO. 2-7
2005 POWER PRODUCTION, PLANT EFFICIENCY AND POWER PRODUCTION COSTS

Month	Total kWh	Days in Month	Average kWh Per Day	Average kW	Fuel Gallons	Fuel Total Cost	$/kWh	Btu/kWh
Oct-04	158,375	31	5,109	213	12,102	$23,842.71	$0.15	10,767
Nov-04	141,470	30	4,716	196	10,757	$21,729.34	$0.15	10,714
Dec-04	96,110	31	3,100	129	7,662	$15,477.24	$0.16	11,234
Jan-05	109,620	31	3,536	147	8,123	$16,164.77	$0.15	10,442
Feb-05	175,910	28	6,283	262	13,877	$26,921.57	$0.15	11,116
Mar-05	145,005	31	4,678	195	11,660	$23,204.39	$0.16	11,331
Apr-05	159,335	30	5,311	221	12,504	$25,508.16	$0.16	11,058
May-05	123,690	30	4,123	172	9,348	$19,537.53	$0.16	10,649
Jun-05	131,670	30	4,389	183	10,075	$21,057.80	$0.16	10,782
Jul-05	155,155	31	5,005	209	11,631	$24,657.72	$0.16	10,563
Aug-05	228,480	31	7,370	307	17,617	$41,049.47	$0.18	10,865
Sep-05	132,300	30	4,410	184	10,227	$26,387.72	$0.20	10,893

TABLE NO. 2-8
2006 POWER PRODUCTION, PLANT EFFICIENCY AND POWER PRODUCTION COSTS

Month	Total kWh	Days in Month	Average kWh Per Day	Average kW	Fuel Gallons	Fuel Total Cost	$/kWh	Btu/kWh
Oct-05	131,565	31	4,244	177	10,219	$27,388.79	$0.21	10,945
Nov-05	160,650	30	5,355	223	12,327	$31,805.72	$0.20	10,812
Dec-05	69,965	31	2,257	94	5,904	$15,234.38	$0.22	11,891
Jan-06	95,445	31	3,079	128	7,529	$17,168.17	$0.18	11,115
Feb-06	119,315	28	4,261	178	10,060	$22,937.71	$0.19	11,881
Mar-06	122,990	31	3,967	165	9,733	$22,677.89	$0.18	11,151
Apr-06	178,920	30	5,964	249	14,415	$33,587.64	$0.19	11,353
May-06	121,730	30	4,058	169	10,733	$27,155.24	$0.22	12,424
Jun-06	175,665	30	5,856	244	14,177	$36,860.20	$0.21	11,372

SECTION 3

ECONOMIC AND ENGINEERING OPTIONS FOR CHP

Utility Rates and Charges

KIUC currently charges a lump sum customer charge, a demand charge ($/kW), and an energy charge ($/kWh). The demand charge is multiplied by the larger of the peak demand at each customer's meter each month, or 75 percent of the eleventh month prior historical recorded peak. The energy charge is multiplied by the kWh consumed each month. As shown in Section 2, PMRF currently pays KIUC about $0.30/kWh for electric service (inclusive of demand charge, energy charge, and customer charge). Copies of recent KIUC rate sheets can be found in Appendix B.

The demand charge and the energy charge are the same for all hours during the day and for all months during the year. KIUC's rates do not vary with time-of-use (daytime versus nighttime) or by season (winter versus summer).

The biggest factor affecting the energy charge is the price of diesel oil. Most of KIUC's power is produced using diesel oil.

CHP Technical Alternatives

A number of technical alternatives are available for configuring a CHP project at PMRF. The alternatives include:

- Continue to use the existing reciprocating engines, fired on diesel oil, with the addition of heat recovery equipment;
- Convert the existing reciprocating engines to landfill gas firing, with the addition of heat recovery equipment;
- Install new landfill gas fueled reciprocating engines, microturbines or fuel cells, equipped with heat recovery. The new equipment could be installed at the location of the existing power plant or at another location; or
- Install new landfill gas fired reciprocating engines, microturbines or fuel cells, without heat recovery, at a site on or close to the landfill. The economic advantage to this alternative is that it would eliminate most or all of the landfill gas transmission pipeline, and it would reduce the compression equipment requirements. Evaluation of this alternative will be considered under the work plan's directive to consider "any other options determined by the Contractor to be viable." The power produced under this alternative could be put on KIUC's grid or PMRF's grid.

As discussed in Section 2, there is no demand for steam and there is no significant demand for hot water at PMRF. A heat demand could be created, however, by installation of absorption chillers to meet cooling loads that are currently met by other cooling technologies. The chillers would satisfy selected air conditioning loads, and reduce electric power consumption. Absorption chillers can use steam or hot water to produce chilled water. A central chilled water unit could be established immediately adjacent to the existing or new power production equipment, with chilled water delivered to the points of end use, or hot water could be delivered to absorption chillers, located at the points of end use.

Thermal energy can be recovered as hot water from a reciprocating engine's jacket water and lube oil cooler, or as hot water or as steam from the engine's exhaust stack. Hot water can be recovered from a microturbine's exhaust. Steam or hot water can be recovered from a fuel cell's exhaust.

Fuel Existing Engines on Diesel Oil with the Addition of Heat Recovery

Based on Caterpillar's data sheets for the Model 3508 engine, and SCS's assessment of the typical performance of heat exchangers installed in an engine's cooling water loop and stack, SCS estimates that 1.0 mmBtu/hr of hot water can be recovered from a Model 3508's jacket water and lube oil, and an additional 1.3 mmBtu/hr can be recovered from its exhaust, when the engine is operating at its full capacity of 600 kW. The Model 3412 engine will produce 0.5 mmBtu/hr of hot water from its jacket water and lube oil, and an additional 0.6 mmBtu/hr from its exhaust, again when operating at full output.

Currently, the engines operate only eight hours per day, the two 600 kW engines operate at about 40 percent of their rated capacity, and one of the three 300 kW engines operates at 60 percent of its rated capacity. The limited operating schedule of the engines greatly reduces the heat generation potential of the existing power plant. When operating at full output, the existing PMRF power plant could produce about 108 tons of cooling, using a single-effect hot water absorption chiller.

Buildings 105, 105ROCS and 130 represent a cluster of significant cooling loads. The buildings have an installed capacity of 205 tons of cooling. The basic CHP configuration to be considered under this alternative will be installation of a 108 ton absorption chiller at the existing PMRF power plant, and installation of insulated, underground cold water delivery and warm water return piping to serve these three buildings. It will be necessary to leave the existing electric drive cooling equipment in place at each building. The existing equipment will operate during the periods of time when the PMRF power plant is offline, and to supplement the cooling provided by the 108 ton chiller, during periods when the cooling load exceeds 108 tons.

While the cooling loads at Buildings 300 and 384, to the north, and Buildings 1262, 1261 and 1264, to the south, are too far away from the existing PMRF power plant to make delivery of

chilled water economically feasible, the existing cooling loads in the immediate vicinity of the existing PMRF power plant could use all of the available waste heat from the existing power plant.

Fuel Existing Engines on Landfill Gas with the Addition of Heat Recovery

The existing reciprocating engines are diesel engines, as contrasted to spark-ignited engines. Natural gas fired engines and landfill gas fired engines are spark-ignited engines. It is possible to operate a diesel engine on a gaseous fuel, if properly configured, and if some diesel fuel is injected as a pilot fuel. Significant modifications must be made to the existing engines to allow them to use natural gas as a fuel.

The amount of landfill gas available at Kekaha Landfill in 2007 will support production of about 1,100 kW of power. Conversion of the two 600 kW engines to landfill gas firing would cover the amount of landfill gas currently available.

Caterpillar has never converted one of their diesel fired engines to landfill gas firing, and there are technical, performance and cost uncertainties associated with such a conversion. Due to these uncertainties, SCS recommends that further consideration not be given to this alternative.

New Reciprocating Engines Fired on Landfill Gas at Existing PMRF Power Plant

Engine Selection

The amount of landfill gas available in 2007 will support about 1,100 kW. By 2010, the amount of landfill gas available will support about 1,600 kW. By 2017, the amount of landfill gas available will support about 2,000 kW.

SCS will assume that two Caterpillar Model 3516 engines will be employed. Model 3516 is the most widely used landfill gas fired engine in the United States. It has a capacity of 820 kW, and a heat rate of 10,900 Btu/kWh (HHV). It requires a landfill gas supply pressure of 3 psig.

Heat Recovery

The amount of recoverable heat from the Model 3516's jacket water and lube oil is 2.5 mmBtu/hr per engine. The amount of heat recoverable from the exhaust stack is 1.1 mmBtu per engine. About 310 tons of cooling could be provided by the 7.2 mmBtu/hr of waste heat available from a 1,640 kW power plant.

The two new engines would be installed in a building in the vicinity of the existing PMRF power plant. The existing step-up transformer could be used to introduce power to the grid. The new landfill gas fired power plant would operate continuously, unlike the existing PMRF power

plant. Excess power produced during the night or during the day would be sold to KIUC. As a result, chilled water could be produced continuously, rather than intermittently. The existing electric-drive chillers would remain in-place, and be used if the landfill gas fired power plant was offline for maintenance or was offline due to a landfill gas supply interruption. An online time of 95 percent, or better, can be expected for the landfill gas fired power plant. The power plant would be staffed during the daylight shift during the five weekdays, and would operate unattended at all other times. Power plant shutdowns or problems during the unattended hours would be addressed by the operator responding to an automatic callout on overtime.

A 205 ton single-effect, hot water absorption chiller would be installed, along with chilled water supply and return piping to Buildings 105, 105ROCS, and 103.

Air Emissions

Air emissions for two Model 3516 engines fired on landfill gas would be as follows:

Parameter	g/bhp-hr	Tons per Year
NO_x	0.60	18.6
CO	2.50	93.1
VOC	0.80	24.8
SO_x	0.01	0.3
Particulates	0.10	3.1

The above emission rates represent Best Available Control Technology (BACT) for landfill gas fired reciprocating engines.

Microturbines

Microturbines are available in the following incremental capacities -- 30 kW, 60 kW, 70 kW, and 250 kW. Microturbines are less efficient than reciprocating engines. They have a higher heat rate, 12,000 Btu/kWh (HHV) to 13,900 Btu/kWh (HHV), versus 10,900 Btu/kWh (HHV) for the Model 3516 engine. Microturbines are applicable to smaller projects (< 800 kW). The Model 3516 engine (820 kW) is the smallest engine commonly in use on landfill gas.

Microturbines are not a viable alternative to reciprocating engines for the main PMRF power plant because of their lower efficiency and their higher installed cost. The installed cost of a microturbine facility at an output in the vicinity of 800 kW would be about $2,200/kW versus $1,600/kW for a reciprocating engine plant.

Microturbines could be considered as the power generation component of a CHP project to serve Buildings 1261, 1262 and 1264. If landfill gas is piped to a new power plant, located in the vicinity of the existing PMRF power plant, the landfill gas transmission pipeline will pass

Building 1262 on the route to the new power plant. A landfill gas fired microturbine power plant could be installed in the vicinity of Building 1262.

United Technologies (UT) offers a microturbine package coupled with an absorption chiller. The smallest package offered by UT incorporates four 60 kW microturbines, and a double-effect, hot gas absorption chiller. The package can produce 120 tons of cooling and 1.1 mmBtu/hr of hot water. It would require 100 scfm of landfill gas.

A microturbine CHP plant serving Buildings 1261, 1262 and 1264 can be considered to be an optional, add-on project, to the above-described new power plant project. The microturbine CHP plant project would consist of the following elements:

- A UT microturbine CHP package, incorporating four 60 kW microturbines, an absorption chiller, and hot water recovery module;
- Hot water piping to interface with Building 1262's hot water generator;
- Chilled water supply and return piping to Buildings 1261, 1262 and 1264;
- Conversion of the air handling equipment in these buildings to accommodate chilled water; and
- A landfill gas treatment and pressure booster skid. The microturbines require a pressure of 80 psig. The microturbines also require a landfill gas which is 100 percent free of siloxane. The skid will incorporate an activated carbon vessel, a booster compressor, and an air-to-gas aftercooler.

The small CHP plant will be located in the vicinity of Building 1262. The microturbines will connect to the grid at 480 V. The Navy Housing grid will be able to absorb all of the power produced by the microturbines virtually all of the time.

The microturbines will consume about 100 scfm of landfill gas (about 3.0 mmBtu/hr). The consumption of fuel by the microturbines will reduce the amount of fuel available for the above-described new power plant, and reduce the amount of power it produces.

Air emissions from the microturbine CHP plant are expected to be as follows:

Parameter	Lbs/MWh	Tons per Year
NO_x	0.25	0.3
CO	0.25	0.3
VOC	2.18	2.5
SO_x	0.03	< 0.1
Particulates	0.33	0.4

The above air emission rates represent BACT.

Fuel Cells

Fuel cells offer the benefits of high efficiency and low air emissions. Fuel cells have been employed on one landfill gas fueled demonstration project. The installed cost of a biogas fueled fuel cell power plant is about four times more expensive than a reciprocating engine plant on a $/kW basis. The fuel cell's operation/maintenance costs are also much higher.

Fuel cells will not be given further consideration in this study because of their high cost and lack of experience on landfill gas.

Reciprocating Engines at or Close to the Landfill Without Heat Recovery

A reciprocating engine plant could be installed on the landfill grounds and interconnect directly to KIUC, or it could be installed just inside PMRF grounds and tie into the PMRF 12.47 kV line serving the Kokole Point power distribution system.

If PMRF owned a power plant at the landfill, it would be necessary to secure an agreement from KIUC to "wheel" power from the interconnection with KIUC at the landfill, through KIUC's power distribution system, to PMRF's points of interconnection with KIUC. Alternatively, the output of the power plant could be sold to KIUC.

If interconnected at Kokole Point, connecting transmission lines would need to be installed between Kokole Point and Navy Housing, and between the Navy Housing and the PMRF Main Base power distribution systems. It may also be necessary to reinforce some of the existing transmission lines within Kokole Point and Navy Housing. In addition, Navy Housing and PMRF Main Base would need to be disconnected from KIUC at their current points of interconnection.

In implementing the above interconnections, it is likely that some of the existing transmission lines and/or transformers will need to be upgraded to carry additional power. The costs of these upgrades must be factored into alternatives requiring interconnections inside of PMRF's grounds.

Engine Selection

Two Model 3516 engines would be employed.

Air Emissions

The air emissions under this alternative would be identical to the air emissions for the above-described new power plant at the site of the existing PMRF power plant.

Utility Interconnection Requirements

KIUC has been contacted, and they have supplied SCS with their interconnection requirements. The requirements are typical of those in use in the electric power industry. The construction cost estimates that will be developed by SCS for the next deliverable will include the cost of complying with these requirements.

SECTION 4

THERMAL ENERGY DISTRIBUTION ALTERNATIVES

The decisions discussed in Section 3, with respect to the configuration of the CHP alternatives, largely dictate the manner in which thermal energy will be distributed on this project.

The absorption chillers that will serve the chilled water cluster located near the existing PMRF power plant, and the potential chilled water cluster at Building 1262, are relatively small. It is clearly more practical to have one larger chiller, rather than three smaller distributed chillers at each of these locations. Distributed chillers would require that hot water be distributed, rather than chilled water. The decision to have central chillers dictates that thermal energy be distributed in the form of chilled water.

In addition to its cooling requirement, Building 1262 has a hot water requirement. The microturbine CHP plant can only produce hot water (not steam). Hot water will be distributed. Even if the production of steam was possible, hot water would be preferred since the end use is proximate to the microturbine, and since the thermal end use is for hot water.

SECTION 5

LANDFILL GAS PRESSURIZATION AND TREATMENT REQUIREMENTS

Based on the evaluation of economic and engineering options completed in Section 3, it may be possible to use landfill gas to fire reciprocating engines or microturbines. The reciprocating engines could be located at the landfill, close to the landfill on the PMRF grounds, or in the vicinity of the existing PMRF power plant. The microturbines would be located in the Navy Housing area in the vicinity of Building 1262.

The reciprocating engines will require a landfill gas supply pressure of about 3 psig. The landfill gas from Kekaha Landfill has low concentrations of hydrogen sulfide (H_2S), siloxane and other compounds that could be deleterious to a reciprocating engine. In addition, the reciprocating engine expected to be used, the Model 3516, has been proven to be tolerant of relatively high concentrations of deleterious compounds. It will be necessary to remove free moisture (i.e., water droplets) and particulate. Free moisture and particulates can be removed through use of a coalescing filter.

Microturbines are less tolerant to hydrogen sulfide and siloxane than reciprocating engines. Microturbine manufacturers require that siloxane not exceed non-detect levels. Siloxane is removed through treatment using activated carbon or silica gel. The landfill gas is processed through a vessel which holds a fixed bed of media. Microturbine manufacturers also require that the landfill gas be dried. Advanced moisture removal is usually accomplished by chilling the landfill gas and then reheating it to achieve a dew point suppression of at least 20° F. The heat used in reheating the landfill gas is waste heat from compression of the landfill gas. Microturbines require a landfill gas supply pressure of 80 psig.

If the reciprocating engines are located at the existing PMRF power plant, a 3.9 mile landfill gas transmission pipeline must be constructed from the Kekaha Landfill to the existing PMRF power plant. A long distance, landfill gas transmission pipeline typically operates at a line pressure of 80 psig (at its point of origin). The optimal operating pressure for a particular pipeline varies based on the economic tradeoff between pipeline cost (a function of its diameter) and the cost of compression (a function of pressure selected). An optimization analysis will be undertaken as part of this study, and the results presented in the Task 3 deliverable.

A sliding vane-type compressor is an appropriate selection for the quantity and pressure of landfill gas under consideration. A pipeline end point pressure of 5 psig will be employed, regardless of the point of origin pressure, ultimately selected by the optimization analysis. For this design concept, there will be no re-compression of landfill gas required at the existing PMRF power plant.

In order to avoid condensate accumulation in the landfill gas transmission line, the compression facility at the landfill will incorporate chilling of the landfill gas to 45° F and reheating by at least 30° F. A coalescing filter will also be provided. The landfill gas pressurization and treatment provided at the landfill will exceed the requirements of the reciprocating engines. A coalescing filter will, however, be located just prior to each engine to provide a final measure of protection.

If the new landfill gas fired power plant is located at the landfill, compression and treatment requirements are greatly simplified. A low pressure, positive displacement-type blower (5 psig maximum) will be employed. The discharge from the blower would be cooled in an air-to-gas cooler (i.e., a radiator). Free moisture would be separated in a moisture separator vessel, and by coalescing filters located at the engines.

If the new landfill gas fired power plant is located just far enough into PMRF grounds to allow its output to be interconnected into the PMRF power grid, then the point of origin compression requirement would increase to no more than 15 psig. A positive displacement-type blower would still be employed; however, chilling and reheating would be added to the process, to prevent condensate accumulation in the pipeline.

The pressure requirement of the microturbines could be met by increasing the pressure of the landfill gas provided by the compressor at the landfill (by 10 psig to 15 psig) to assure that the pressure in the landfill gas transmission pipeline delivered to the microturbines was at least 80 psig. An alternative to increasing the landfill gas pressure provided through the compressor at the landfill is to supply a small booster compressor to serve the microturbines, which would boost the landfill gas pressure from the pipeline pressure at that point on the pipeline to 80 psig. The booster compressor would be located at the microturbine location. The need for a booster compressor will be addressed in conjunction with the aforementioned optimization of pipeline operating pressure. A single activated carbon vessel would be installed to treat the landfill gas being sent to the microturbines. It would be located at the microturbines. The vessel would be about four feet in diameter and about ten feet tall.

SECTION 6

AIR PERMIT CONSIDERATIONS

The Hawaii State Department of Health (HSDH), Environmental Management Division, Clean Air Branch, will be responsible for issuing an air permit for the reciprocating engines and/or the microturbines that might be employed on this project. HSDH will require that Best Available Control Technology (BACT) be employed.

BACT for landfill gas fired reciprocating engines is currently recognized to be:

Parameter	g/bhp-hr
NO_x	0.60
CO	3.00
VOC (NMOC)	0.80
SO_x	0.01
Particulates	0.10

If Kekaha Landfill becomes large enough to be regulated under USEPA's New Source Performance Standards (NSPS) for municipal solid waste landfills, then a more stringent requirement for VOCs might be imposed -- the lesser of 98 percent destruction, or 20 ppmv (as hexane). The SO_x limit is a function of the expected maximum concentration of sulfur-bearing compounds in the landfill gas.

BACT for landfill gas fired microturbines is currently recognized to be:

Parameter	lbs/MWh
NO_x	0.25
CO	0.25
VOC (NMOC)	2.08
SO_x	0.03
Particulates	0.33

Again, SO_x is variable based on the actual quantity of sulfur present in the raw landfill gas.

The air emissions from the landfill gas fired reciprocating engines will be much lower than from the existing diesel engines, and projects recommended by this study would result in a net reduction of air emissions.

SECTION 7

CONCLUSIONS

The following alternatives will be carried forward for detailed technical and economic evaluations to be summarized in the next deliverable. The next deliverable, the Task 3 deliverable, will be prepared by SCS, and is due in October 2006:

Alternative No. 1-A: Fuel the existing engines on diesel oil, with the addition of heat recovery, and retain the current program of intermittent operation;

Alternative No.1-B: Fuel the existing engines on diesel oil, with the addition of heat recovery, and convert to full-time operation;

Alternative No. 2-A: New landfill gas fired reciprocating engines at existing PMRF power plant, with heat recovery to produce chilled water with an absorption chiller, with a microturbine CHP plant at Building 1262;

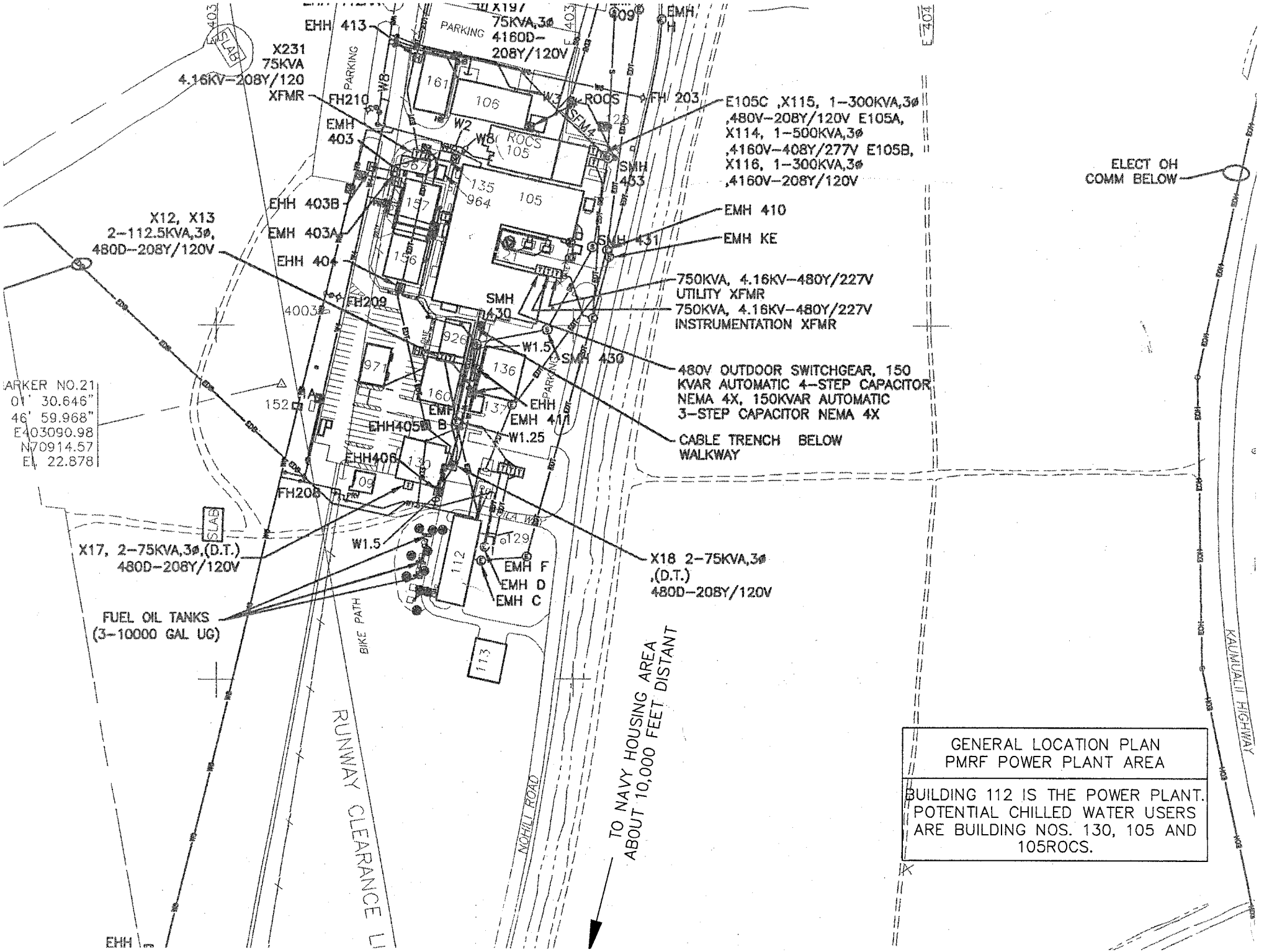
Alternative No.2-B: New landfill gas fired reciprocating engines at existing PMRF power plant, with heat recovery to produce chilled water with an absorption chiller, without a microturbine CHP plant at Building 1262;

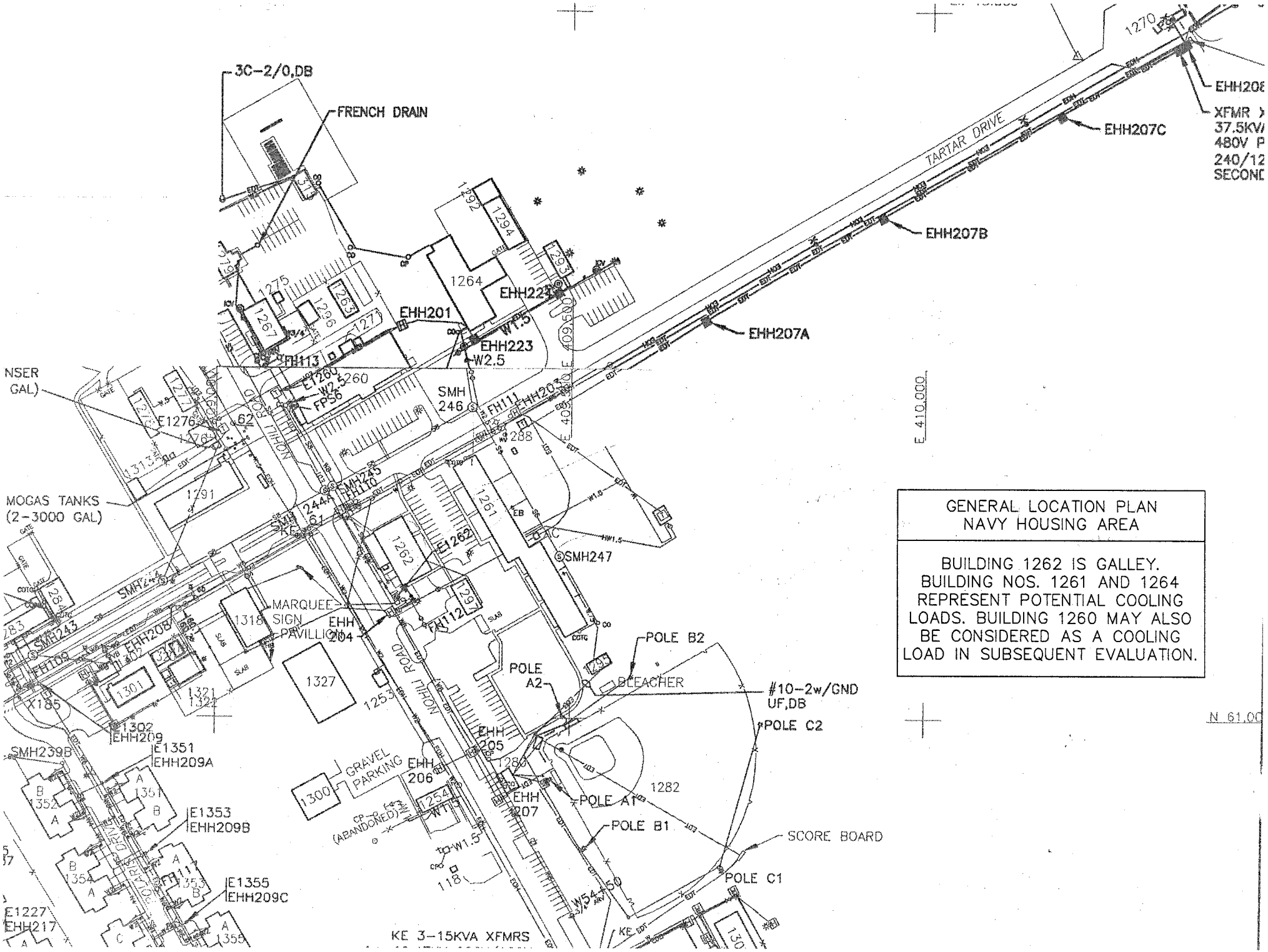
Alternative No.3: New landfill gas fired reciprocating engines on PMRF grounds close to the landfill; and

Alternative No. 4: New landfill gas fired reciprocating engines at the landfill.

APPENDIX A

BUILDING LOCATION PLANS FOR PMRF


EHH 413
X231
75KVA
4.16KV–208Y/120
XFMR
FH210
EMH
403
EHH 403B
EMH 403A
EHH 404
FH209
SMH
430
FH208
X12, X13
2–112.5KVA,3ø,
480D–208Y/120V
X17, 2–75KVA,3ø,(D.T.)
480D–208Y/120V
FUEL OIL TANKS
(3–10000 GAL UG)
X197
75KVA,3ø
4160D–
208Y/120V
FH 203
E105C ,X115, 1–300KVA,3ø
,480V–208Y/120V E105A,
X114, 1–500KVA,3ø
,4160V–408Y/277V E105B,
X116, 1–300KVA,3ø
,4160V–208Y/120V
SMH
433
EMH 410
EMH KE
SMH 431
750KVA, 4.16KV–480Y/227V
UTILITY XFMR
750KVA, 4.16KV–480Y/227V
INSTRUMENTATION XFMR
480V OUTDOOR SWITCHGEAR, 150
KVAR AUTOMATIC 4–STEP CAPACITOR
NEMA 4X, 150KVAR AUTOMATIC
3–STEP CAPACITOR NEMA 4X
CABLE TRENCH BELOW
WALKWAY
X18 2–75KVA,3ø
,(D.T.)
480D–208Y/120V
EMH F
EMH D
EMH C
EMH 411
EHH405
EHH406
ELECT OH
COMM BELOW
PARKING
ROCS
SFMA
BIKE PATH
RUNWAY CLEARANCE
NOHILI ROAD
KAUMUALII HIGHWAY
TO NAVY HOUSING AREA
ABOUT 10,000 FEET DISTANT
ARKER NO.21
01' 30.646"
46' 59.968"
E403090.98
N70914.57
EL 22.878
GENERAL LOCATION PLAN
PMRF POWER PLANT AREA
BUILDING 112 IS THE POWER PLANT.
POTENTIAL CHILLED WATER USERS
ARE BUILDING NOS. 130, 105 AND
105ROCS.


3C-2/0,DB
FRENCH DRAIN
TARTAR DRIVE
EHH207C
EHH207B
EHH207A
EHH201
EHH223
W1.5
W2.5
FH113
FH111
FH112
SMH 246
SMH247
SMH243
SMH239B
E1260
E1262
E1276
E1351 EHH209A
E1353 EHH209B
E1355 EHH209C
E1227 EHH217
MOGAS TANKS (2-3000 GAL)
MARQUEE SIGN PAVILLION
EHH 204
EHH 205
EHH 206
EHH 207
GRAVEL PARKING
1300
1327
POLE A2
POLE A1
POLE B1
POLE B2
POLE C1
POLE C2
BLEACHER
#10-2w/GND UF,DB
SCORE BOARD
KE 3-15KVA XFMRS
NOHILL ROAD
E 410,000
N 61,00
GENERAL LOCATION PLAN
NAVY HOUSING AREA
BUILDING 1262 IS GALLEY. BUILDING NOS. 1261 AND 1264 REPRESENT POTENTIAL COOLING LOADS. BUILDING 1260 MAY ALSO BE CONSIDERED AS A COOLING LOAD IN SUBSEQUENT EVALUATION.

APPENDIX B

RECENT KIUC RATE SHEETS

RATE DATA SHEET

	BASE RATES EFFECTIVE 01-Nov-98	(1) EFFECTIVE RATES 01-Sep-06
SCHEDULE "D" - RESIDENTIAL		
-Customer charge (per Customer, per month)	$9.72	$9.72
-All kWh per month (add to customer charge)	$0.17489	$0.34020
-The minimum monthly charge shall be	$12.16	$12.16
SCHEDULE "G" - GENERAL LIGHT & POWER SERVICE (Small Commercial):		
(Not greater than 30 kW demand and 10,000 kWh use per month)		
-Customer charge (per customer, per month)	$21.89	$21.89
-All kWh per month (add to customer charge)	$0.19118	$0.35745
-The minimum monthly charge shall be	$24.31	$24.31
SCHEDULE "J" - GENERAL LIGHT & POWER SERVICE (Large Commercial):		
(Greater than 30 kW and less than 100 kW demand or 10,000 kWh per month)		
-Customer charge (per customer, per month)	$36.48	$36.48
-Demand charge per kW of monthly demand	$6.08	$6.08
-Energy charge (added to demand charge)		
-All kWh per month (add to customer charge)	$0.16031	$0.32658
-The minimum monthly charge shall not be less than	$182.37	$182.37
SCHEDULE "L" - LARGE POWER (Primary)		
(Demand greater than 100 kW - metered on primary side of meter)		
-Customer charge (per customer, per month)	$334.35	$334.35
-Demand charge per kW of monthly demand	$13.13	$13.13
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.14366	$0.30993
All over 400 kWh per kW of billing demand	$0.12540	$0.29167
-Minimum monthly charge: Customer + Demand Charge		
SCHEDULE "P" - LARGE POWER (Secondary)		
(Demand greater than 100 kW - metered on secondary side of meter)		
-Customer charge (per customer, per month)	$346.51	$346.51
-Demand charge per kW of monthly demand	$10.45	$10.45
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.15279	$0.31906
All over 400 kWh per kW of billing demand	$0.13324	$0.29951
-Minimum monthly charge: Customer + Demand Charge		

	Effective Annual Rate 01-Jan-06	Prior Month's Rate 01-Aug-06
SCHEDULE "Q" MODIFIED - COGENERATORS		
-Energy credit payment rate to customers (per kWh)	$0.14730	$0.18810
SCHEDULE "SL" - STREET LIGHTING		
(Depending on type of service)		
-All kWh per month (add to fixture charge)	$0.23339	$0.39860
-The minimum monthly charge shall be the fixture charge		
-Fixture charge (per fixture-per month multiplied by no. of fixtures)		
HPS 100 W (per fixture-per month)	$5.74	
HPS 150 W (per fixture-per month)	$5.74	
HPS 200 W (per fixture-per month)	$5.95	
HPS 250 W (per fixture-per month)	$5.95	
HPS 400 W (per fixture-per month)	$6.20	

ENERGY RATE ADJUSTMENT FACTORS:	
Schedule D, G, J, L, P, SL	$0.16464
Schedule Q	$0.04080

(See rate schedules for additional information)

MONTHLY EFFECTIVE RATES INCLUDE:	
(1) kWh increase to base energy rates for ENERGY RATE ADJUSTMENT CLAUSE	$0.16464
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule D	$0.000674
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule G	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule J	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule L	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule P	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule SL	$0.000576

RATE DATA SHEET

	BASE RATES EFFECTIVE 01-Nov-98	(1) EFFECTIVE RATES 01-Aug-06
SCHEDULE "D" - RESIDENTIAL		
-Customer charge (per Customer, per month)	$9.72	$9.72
-All kWh per month (add to customer charge)	$0.17489	$0.33619
-The minimum monthly charge shall be	$12.16	$12.16
SCHEDULE "G" - GENERAL LIGHT & POWER SERVICE (Small Commercial):		
(Not greater than 30 kW demand and 10,000 kWh use per month)		
-Customer charge (per customer, per month)	$21.89	$21.89
-All kWh per month (add to customer charge)	$0.19118	$0.35344
-The minimum monthly charge shall be	$24.31	$24.31
SCHEDULE "J" - GENERAL LIGHT & POWER SERVICE (Large Commercial):		
(Greater than 30 kW and less than 100 kW demand or 10,000 kWh per month)		
-Customer charge (per customer, per month)	$36.48	$36.48
-Demand charge per kW of monthly demand	$6.08	$6.08
-Energy charge (added to demand charge)		
-All kWh per month (add to customer charge)	$0.16031	$0.32257
-The minimum monthly charge shall not be less than	$182.37	$182.37
SCHEDULE "L" - LARGE POWER (Primary)		
(Demand greater than 100 kW - metered on primary side of meter)		
-Customer charge (per customer, per month)	$334.35	$334.35
-Demand charge per kW of monthly demand	$13.13	$13.13
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.14366	$0.30592
All over 400 kWh per kW of billing demand	$0.12540	$0.28766
-Minimum monthly charge: Customer + Demand Charge		
SCHEDULE "P" - LARGE POWER (Secondary)		
(Demand greater than 100 kW - metered on secondary side of meter)		
-Customer charge (per customer, per month)	$346.51	$346.51
-Demand charge per kW of monthly demand	$10.45	$10.45
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.15279	$0.31505
All over 400 kWh per kW of billing demand	$0.13324	$0.29550
-Minimum monthly charge: Customer + Demand Charge		
	Effective Annual Rate 01-Jan-06	Prior Month's Rate 01-Jul-06
SCHEDULE "Q" MODIFIED - COGENERATORS		
-Energy credit payment rate to customers (per kWh)	$0.14730	$0.19600
SCHEDULE "SL" - STREET LIGHTING		
(Depending on type of service)		
-All kWh per month (add to fixture charge)	$0.23339	$0.39459
-The minimum monthly charge shall be the fixture charge		
-Fixture charge (per fixture-per month multiplied by no. of fixtures)		
HPS 100 W (per fixture-per month)	$5.74	
HPS 150 W (per fixture-per month)	$5.74	
HPS 200 W (per fixture-per month)	$5.95	
HPS 250 W (per fixture-per month)	$5.95	
HPS 400 W (per fixture-per month)	$6.20	

ENERGY RATE ADJUSTMENT FACTORS:	
Schedule D, G, J, L, P, SL	$0.16063
Schedule Q	$0.04870

(See rate schedules for additional information)

MONTHLY EFFECTIVE RATES INCLUDE:	
(1) kWh increase to base energy rates for ENERGY RATE ADJUSTMENT CLAUSE	$0.16063
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule D	$0.000674
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule G	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule J	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule L	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule P	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule SL	$0.000576

RATE DATA SHEET

	BASE RATES EFFECTIVE 01-Nov-98	(1) EFFECTIVE RATES 01-Jul-06
SCHEDULE "D" - RESIDENTIAL		
-Customer charge (per Customer, per month)	$9.72	$9.72
-All kWh per month (add to customer charge)	$0.17489	$0.34215
-The minimum monthly charge shall be	$12.16	$12.16
SCHEDULE "G" - GENERAL LIGHT & POWER SERVICE (Small Commercial):		
(Not greater than 30 kW demand and 10,000 kWh use per month)		
-Customer charge (per customer, per month)	$21.89	$21.89
-All kWh per month (add to customer charge)	$0.19118	$0.35939
-The minimum monthly charge shall be	$24.31	$24.31
SCHEDULE "J" - GENERAL LIGHT & POWER SERVICE (Large Commercial):		
(Greater than 30 kW and less than 100 kW demand or 10,000 kWh per month)		
-Customer charge (per customer, per month)	$36.48	$36.48
-Demand charge per kW of monthly demand	$6.08	$6.08
-Energy charge (added to demand charge)		
-All kWh per month (add to customer charge)	$0.16031	$0.32852
-The minimum monthly charge shall not be less than	$182.37	$182.37
SCHEDULE "L" - LARGE POWER (Primary)		
(Demand greater than 100 kW - metered on primary side of meter)		
-Customer charge (per customer, per month)	$334.35	$334.35
-Demand charge per kW of monthly demand	$13.13	$13.13
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.14366	$0.31187
All over 400 kWh per kW of billing demand	$0.12540	$0.29361
-Minimum monthly charge: Customer + Demand Charge		
SCHEDULE "P" - LARGE POWER (Secondary)		
(Demand greater than 100 kW - metered on secondary side of meter)		
-Customer charge (per customer, per month)	$346.51	$346.51
-Demand charge per kW of monthly demand	$10.45	$10.45
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.15279	$0.32100
All over 400 kWh per kW of billing demand	$0.13324	$0.30145
-Minimum monthly charge: Customer + Demand Charge		
	Effective Annual Rate 01-Jan-06	Prior Month's Rate 01-Jun-06
SCHEDULE "Q" MODIFIED - COGENERATORS		
-Energy credit payment rate to customers (per kWh)	$0.14730	$0.20250
SCHEDULE "SL" - STREET LIGHTING		
(Depending on type of service)		
-All kWh per month (add to fixture charge)	$0.23339	$0.40055
-The minimum monthly charge shall be the fixture charge		
-Fixture charge (per fixture-per month multiplied by no. of fixtures)		
HPS 100 W (per fixture-per month)	$5.74	
HPS 150 W (per fixture-per month)	$5.74	
HPS 200 W (per fixture-per month)	$5.95	
HPS 250 W (per fixture-per month)	$5.95	
HPS 400 W (per fixture-per month)	$6.20	

ENERGY RATE ADJUSTMENT FACTORS:	
Schedule D, G, J, L, P, SL	$0.16658
Schedule Q	$0.05520

(See rate schedules for additional information)

MONTHLY EFFECTIVE RATES INCLUDE:	
(1) kWh increase to base energy rates for ENERGY RATE ADJUSTMENT CLAUSE	$0.16658
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule D	$0.000674
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule G	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule J	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule L	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule P	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule SL	$0.000576

KAUA'I ISLAND UTILITY COOPERATIVE

ENERGY RATE ADJUSTMENT CLAUSE

Current Date:	31-May-06
File No.:	2006-06
Supersedes Sheet Effective:	5/1/06
Effective Date:	6/1/06

RATE DATA SHEET

	BASE RATES EFFECTIVE 01-Nov-98	(1) EFFECTIVE RATES 01-Jun-06
SCHEDULE "D" - RESIDENTIAL		
-Customer charge (per Customer, per month)	$9.72	$9.72
-All kWh per month (add to customer charge)	$0.17489	$0.34832
-The minimum monthly charge shall be	$12.16	$12.16
SCHEDULE "G" - GENERAL LIGHT & POWER SERVICE (Small Commercial):		
(Not greater than 30 kW demand and 10,000 kWh use per month)		
-Customer charge (per customer, per month)	$21.89	$21.89
-All kWh per month (add to customer charge)	$0.19118	$0.36557
-The minimum monthly charge shall be	$24.31	$24.31
SCHEDULE "J" - GENERAL LIGHT & POWER SERVICE (Large Commercial):		
(Greater than 30 kW and less than 100 kW demand or 10,000 kWh per month)		
-Customer charge (per customer, per month)	$36.48	$36.48
-Demand charge per kW of monthly demand	$6.08	$6.08
-Energy charge (added to demand charge)		
-All kWh per month (add to customer charge)	$0.16031	$0.33470
-The minimum monthly charge shall not be less than	$182.37	$182.37
SCHEDULE "L" - LARGE POWER (Primary)		
(Demand greater than 100 kW - metered on primary side of meter)		
-Customer charge (per customer, per month)	$334.35	$334.35
-Demand charge per kW of monthly demand	$13.13	$13.13
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.14366	$0.31805
All over 400 kWh per kW of billing demand	$0.12540	$0.29979
-Minimum monthly charge: Customer + Demand Charge		
SCHEDULE "P" - LARGE POWER (Secondary)		
(Demand greater than 100 kW - metered on secondary side of meter)		
-Customer charge (per customer, per month)	$346.51	$346.51
-Demand charge per kW of monthly demand	$10.45	$10.45
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.15279	$0.32718
All over 400 kWh per kW of billing demand	$0.13324	$0.30763
-Minimum monthly charge: Customer + Demand Charge		
	Effective Annual Rate 01-Jan-06	Prior Month's Rate 01-May-06
SCHEDULE "Q" MODIFIED - COGENERATORS		
-Energy credit payment rate to customers (per kWh)	$0.14730	$0.18260
SCHEDULE "SL" - STREET LIGHTING		
(Depending on type of service)		
-All kWh per month (add to fixture charge)	$0.23339	$0.40672
-The minimum monthly charge shall be the fixture charge		
-Fixture charge (per fixture-per month multiplied by no. of fixtures)		
HPS 100 W (per fixture-per month)	$5.74	
HPS 150 W (per fixture-per month)	$5.74	
HPS 200 W (per fixture-per month)	$5.95	
HPS 250 W (per fixture-per month)	$5.95	
HPS 400 W (per fixture-per month)	$6.20	

ENERGY RATE ADJUSTMENT FACTORS:	
Schedule D, G, J, L, P, SL	$0.17276
Schedule Q	$0.03530

(See rate schedules for additional information)

MONTHLY EFFECTIVE RATES INCLUDE:	
(1) kWh increase to base energy rates for ENERGY RATE ADJUSTMENT CLAUSE	$0.17276
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule D	$0.000674
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule G	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule J	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule L	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule P	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule SL	$0.000576

RATE DATA SHEET

	BASE RATES EFFECTIVE 01-Nov-98	(1) EFFECTIVE RATES 01-May-06
SCHEDULE "D" - RESIDENTIAL		
-Customer charge (per Customer, per month)	$9.72	$9.72
-All kWh per month (add to customer charge)	$0.17489	$0.32476
-The minimum monthly charge shall be	$12.16	$12.16
SCHEDULE "G" - GENERAL LIGHT & POWER SERVICE (Small Commercial):		
(Not greater than 30 kW demand and 10,000 kWh use per month)		
-Customer charge (per customer, per month)	$21.89	$21.89
-All kWh per month (add to customer charge)	$0.19118	$0.34201
-The minimum monthly charge shall be	$24.31	$24.31
SCHEDULE "J" - GENERAL LIGHT & POWER SERVICE (Large Commercial):		
(Greater than 30 kW and less than 100 kW demand or 10,000 kWh per month)		
-Customer charge (per customer, per month)	$36.48	$36.48
-Demand charge per kW of monthly demand	$6.08	$6.08
-Energy charge (added to demand charge)		
-All kWh per month (add to customer charge)	$0.16031	$0.31114
-The minimum monthly charge shall not be less than	$182.37	$182.37
SCHEDULE "L" - LARGE POWER (Primary)		
(Demand greater than 100 kW - metered on primary side of meter)		
-Customer charge (per customer, per month)	$334.35	$334.35
-Demand charge per kW of monthly demand	$13.13	$13.13
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.14366	$0.29449
All over 400 kWh per kW of billing demand	$0.12540	$0.27623
-Minimum monthly charge: Customer + Demand Charge		
SCHEDULE "P" - LARGE POWER (Secondary)		
(Demand greater than 100 kW - metered on secondary side of meter)		
-Customer charge (per customer, per month)	$346.51	$346.51
-Demand charge per kW of monthly demand	$10.45	$10.45
-Energy charge (added to demand charge)		
First 400 kWh per kW of billing demand	$0.15279	$0.30362
All over 400 kWh per kW of billing demand	$0.13324	$0.28407
-Minimum monthly charge: Customer + Demand Charge		
	Effective Annual Rate 01-Jan-06	Prior Month's Rate 01-Apr-06
SCHEDULE "Q" MODIFIED - COGENERATORS		
-Energy credit payment rate to customers (per kWh)	$0.14730	$0.16810
SCHEDULE "SL" - STREET LIGHTING		
(Depending on type of service)		
-All kWh per month (add to fixture charge)	$0.23339	$0.38316
-The minimum monthly charge shall be the fixture charge		
-Fixture charge (per fixture-per month multiplied by no. of fixtures)		
HPS 100 W (per fixture-per month)	$5.74	
HPS 150 W (per fixture-per month)	$5.74	
HPS 200 W (per fixture-per month)	$5.95	
HPS 250 W (per fixture-per month)	$5.95	
HPS 400 W (per fixture-per month)	$6.20	

ENERGY RATE ADJUSTMENT FACTORS:	
Schedule D, G, J, L, P, SL	$0.14920
Schedule Q	$0.02080

(See rate schedules for additional information)

MONTHLY EFFECTIVE RATES INCLUDE:	
(1) kWh increase to base energy rates for ENERGY RATE ADJUSTMENT CLAUSE	$0.14920
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule D	$0.000674
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule G	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule J	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule L	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule P	$0.001630
(1) kWh increase to base energy rates for RESOURCE COST SURCHARGE - Schedule SL	$0.000576